SURVEYING GULF WAR AIRPOWER

By THOMAS A. KEANEY

U.S. Navy (Dave Parsons)

F–14A Tomcat from *USS John F. Kennedy* refueling from KC–10A Extender.

Hardened shelter at Al Jaber Air Base, Kuwait, hit by laser-guided bombs.

DOD

Despite the profound impact of airpower on the course and outcome of the Gulf War, its employment has not escaped controversy. The coalition quickly cleared the skies of Iraqi aircraft, neutralized Iraqi medium and high altitude air defenses, brought Iraq's entire command structure and military under attack, and systematically struck at the Iraqi field army in the Kuwait theater of operations. As a result, the campaign culminated in a brief, overwhelming ground offensive over a demoralized and shattered Iraqi army. Still, there were doubts concerning airpower's contributions and effectiveness. Controversy arose during the war over the accuracy of official claims regarding the numbers of Iraqi tanks and mobile Scuds destroyed by air attack. After the war there were attempts by airpower enthusiasts to view the bombing as the harbinger of a new era of precision attacks from the air while skeptics argued that bombing had been far less accurate than claimed, overzealous in its pursuit of fleeing Iraqi troops, or wanton in its unnecessary destruction of Iraq's civil infrastructure. These various claims drew on evidence that came in many forms: the accounts by participants (including pilot reports) and by visitors to Iraq both during and after the war, prisoner of war

Summary

Airpower dominated the Gulf War, but what did it accomplish? How successful were coalition air attacks against specific target sets—from Iraq's nuclear weapons facilities and mobile Scuds to its tanks in the Kuwait theater? The information gathered during the course of a survey commissioned by the Secretary of the Air Force confirms the dominant role of airpower while illustrating that the indirect rather than the direct effects of bombing were perhaps of more importance. Moreover, it is apparent from the results of this survey that inaccuracies are inherent in wartime assessments and that one must contend with incomplete knowledge of the target base and enemy countermeasures. Even in a conflict of short duration when many collection measures are employed, the problems of assessing (*not* measuring) operational and strategic effectiveness remain as difficult, controversial, and afflicted by subjectivity as they have in wars of the past.

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Map courtesy of the Central Intelligence Agency.

interrogations, and still photography and videotape of targets either destroyed or under attack. Discounting claims by those who simply marshalled evidence in support of their own agendas, there still appeared to be credible evidence that documented diverse interpretations of what bombing had or had not accomplished. What appeared to be a short, clear-cut victory with airpower playing a leading if not dominant role became another battleground for competing sets of data and contrasting interpretations of events. This later battleground centered on the difficult problem of damage assessment, particularly the proper measures of the damage.

Shortly after the conflict in the Gulf, then Secretary of the Air Force Donald Rice initiated a comprehensive survey of airpower employment in an attempt to sort out varying interpretations of its role and effectiveness during the war. Part of this survey—in which the author participated—addressed the effectiveness of coalition bombing.[1] Judgments made in the course of that survey and experience gained in analyzing divergent data and differing interpretations of the air campaign form the basis of this article. In brief, research for the survey involved three steps: understanding what happened as the result of bomb or missile attacks, determining the proper measurement of the result, and then relating cause and effect—how actions or results achieved objectives of air attacks. It may be useful to begin with some concrete examples of the complexity of such assessments.

First, consider the evidence available in a photograph of a destroyed tank or aircraft. If the tank's turret has been blown off the hull or the aircraft reduced to rubble, then the assessment of results is easy: the equipment is unusable. Next, consider the evidence of a photo of a command bunker or aircraft shelter with a hole in the roof of the kind commonly made by a precision-guided bomb with a hard-target-penetrating warhead. Although the bomb obviously hit the target, did it penetrate into and detonate in the interior? And if so, was the structure occupied at the time? The problematic answers to these questions make assessing what happened far more difficult than in the initial case. Finally, consider a situation where there is no photo, only a pilot report claiming that an Iraqi tank or hardened aircraft shelter was hit with a precision-guided bomb. Uncertainty surrounding such results is even greater than in the second case. While somewhat idealized all these cases suggest experiences during and after the Gulf War that confronted analysts attempting to answer the most basic of questions: what happened? In many instances more authoritative data which corrected earlier impressions became available only after the war.

Taking the next step, determining what to measure, requires a knowledge of the objectives sought by the attacks. Not only do numbers or pictures fail to speak for themselves, they might not be the correct numbers or pictures. Consider, for example, a comparison of Iraqi and coalition aircraft shot down as a measure of the effectiveness of the air forces involved, a common indicator used in past wars to determine the performance of opposing air forces. The scorecard would read 33 Iraqi aircraft to 38 coalition, which in isolation suggests a slight advantage in Iraq's favor. On the other hand the coalition scored 33-to-1 in air-to-air combat, and fixed-wing aircraft

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flew some 69,000 *shooter* sorties to an estimate of fewer than 500 for Iraq. Notwithstanding a coalition/Iraqi combat-loss ratio of 33-to-38, the figures indicate that coalition air forces had overwhelming ratios in air-to-air combat and shooter sorties. This illustrates an extreme case, but it also demonstrates the importance of selecting proper measures as well as the ease with which legitimate evidence can be used to support widely differing interpretations of what happened. In the end, measurement means little until a sensible and reasonably broad set of measures has been selected.

The third step, determining what the data means, is related closely to the second in that the requirement is to show how results relate to attaining objectives. In this step one must deal with a hierarchy of objectives: from the tactical (destroying tanks) to higher levels (preventing an armored attack or degrading the combat capability of a division or corps). Also note that tactical measures of effects are usually more easily tabulated and understood than operational-level measures—one can count tanks but how is divisional degradation quantified? As a result, quite often operational-level objectives are presumed to be a direct function of tactical damage assessments. That match is not always improper but, as illustrated by the case of aggregate combat losses due to enemy air defenses as a measure of air supremacy, it can be extremely misleading.

Before discussing the assessments, it seems appropriate to provide a brief summary of the operational objectives for the air campaign found in the Operation Desert Storm plan: (1) isolate and incapacitate the Iraqi regime by attacks on leadership facilities, electric power production, and telecommunications; (2) gain and maintain air supremacy by attacks on the air defense system and the air force; (3) destroy nuclear, biological, and chemical warfare (NBC) capabilities; (4) eliminate offensive military capabilities by attacks on logistical sites, Scud missiles and launchers, oil refining and distribution facilities, and naval forces and bases; and (5) render the Iraqi army ineffective and isolate it in the Kuwait theater by attacks on railroads and bridges and on the units themselves, particularly the Republican Guard. To attain these objectives planners identified twelve target sets, all of which are listed above in the context of the objectives sought.[2]

Command of the Air

The contest for command of the air over Iraq and the Kuwait theater revealed the difficulty of measuring effectiveness. In the most complex operations of the war the coalition initiated the air offensive by taking down the command and control of the Iraqi air defense network, bottling up Iraqi aircraft on their bases, and suppressing radar-guided surface-to-air missiles (SAMs) through a combination of drone decoys and anti-radiation missiles employed against SAM radar sites. The results were spectacular in terms of what coalition aircraft were subsequently able to accomplish offensively and with slight losses: except for low-altitude antiaircraft artillery and infrared SAMs in a few highly defended areas too numerous to destroy wholesale, coalition aircraft gained relatively unimpeded freedom of action throughout the theater. Since the Iraqis probably never intended to contest air superiority even over Iraq itself at the risk of losing their modern fixed-wing aircraft, bottling them up in supposedly bomb-proof shelters was relatively easy. The crux of the coalition air-control problem lay then in taking radar-guided SA–2s, SA–3s, SA–6/8s, and Rolands out of the fight early in the campaign, a goal achieved as much by intimidation as by destruction. A pivotal measure in this regard was the lack of success recorded by Iraqi radar-guided SAMs in damaging or downing coalition aircraft despite the large number of coalition fixed-wing sorties flown daily. Iraqi radar SAMs damaged or destroyed eight coalition fighters in the first six days of Operation Desert Storm and, for the remaining five weeks of the war, they were only able to hit another five coalition aircraft.

With ground-based defenses suppressed, attention shifted to Iraqi aircraft and an interesting complication that had developed: Iraq decided to fly few sorties, sensing the odds and apparently planning to have its aircraft ride out the war in hardened shelters. More traditional measures of attacking an enemy air force, and of estimating success, had to be rethought. Airfield attacks had begun by targeting runway surfaces in order to limit takeoffs to numbers that coalition fighters could handle, but moved to hardened aircraft shelters when it was decided to eliminate the Iraqi air force's residual capability. At this point, further attacks on runways

ceased to be necessary; in fact the plan became one of attempting to lure Iraqi aircraft into the air. The measurable tactical effects were as follows: of the nearly 600 hardened shelters, some 375 were destroyed by coalition aircraft during the war. While some aircraft were without doubt destroyed in shelters, many more either attempted to flee to Iran or were dispersed in the open in Iraq, both on and off airfields. In either place they became of little use as a fighting force. As a result, by war's end Iraq was able to retain nearly half of its aircraft—an estimated 300 to 375 combat aircraft—but at the expense of forfeiting the use of the air force's entire combat capability during the conflict.

How do you measure the success? Not by the number of Iraqi aircraft shot down—the Iraqis put very few at risk in the air. Over half of the coalition shoot downs of fixed-wing Iraqi aircraft, in fact, occurred as enemy aircraft attempted to flee to Iran after the shelters came under attack. Success was also not measured by the number of SAM sites destroyed—this number, too, can only be guessed at. It was not possible to prove whether a site was destroyed or just silent (or abandoned) because of fear of attack if radars were employed. Destroyed or not, the radar SAMs were not used effectively which was the effect sought. By the number of shelters destroyed? Only indirectly. Attacks on shelters had forced a reaction by the Iraqis, one that caused the loss of their air arm as a force in being, at least in this war. In the end the most telling measures were those things that did *not* happen: the number of coalition aircraft *not* shot down or damaged while flying over 118,000 combat and combat-support missions; the role *not* played by low altitude antiaircraft and SAMs because coalition aircraft could safely fly at higher altitudes; and reconnaissance and strike missions *not* flown by Iraqi aircraft, preserving the surprise of the shift west by coalition ground forces with little fear of attack. The freedom from air attack must be a qualified one because of the threat posed by Scud missiles, a subject addressed later.

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Strategic Target Systems

Attacks on what can be termed core strategic target sets in Iraq offer some of the greatest difficulties in measuring and interpreting effectiveness. The physical damage to some of the target sets often could not be observed, while in the case of others only access to Iraqi decisionmaking processes (or to the thoughts of the decisionmakers) would provide a complete answer. Analyzing effectiveness against these target sets also would involve a discussion of the rather controversial subject of strategic bombing theory, a subject too broad in scope to be dealt with here. Suffice it to say that the stated objectives of strategic bombing in this war were to isolate and disrupt Iraq's political-military leadership and command and control, eliminate offensive capabilities, and destroy NBC capabilities. Targets included national leadership facilities, telecommunications, oil, electric power, NBC facilities, Scuds, and military infrastructure. As a point of reference, the air strikes on all these strategic target sets combined accounted for roughly 15 percent of all air strikes (and 30 percent of the laser-guided bombs) during the war. Attacking a target set, of course, seldom had a single, discrete objective, something that was particularly true for strategic air attacks where combinations of targets attacked simultaneously were important to bringing about the desired effects.

Electric power and oil refining and production facilities are two target sets that historically rank high in strategic bombing campaigns, and the Persian Gulf War was no exception. Coalition plans called for hitting particular aim points in an attempt to limit long-term damage to the facilities (transformer and switching yards rather than generator halls), but the war's objectives were similar to those of past conflicts: interrupt the enemy's industrial and military strength, bring the war home to the country at large, and disrupt civil and military communications. In both electric power and oil production Iraq had nearly twice the capacity needed for all of its domestic and military needs, so extensive damage had to take place to affect Iraq's wartime needs.

Compared with the other strategic targets, collection of information on the tactical damage done to electric and oil facilities was a relatively easy matter. These facilities

Lockheed (Schulzinger and Lombard)

F–117s comprised only 2 percent of all coalition combat aircraft but carried out approximately 40 percent of the strategic target attacks using laser-guided bombs.

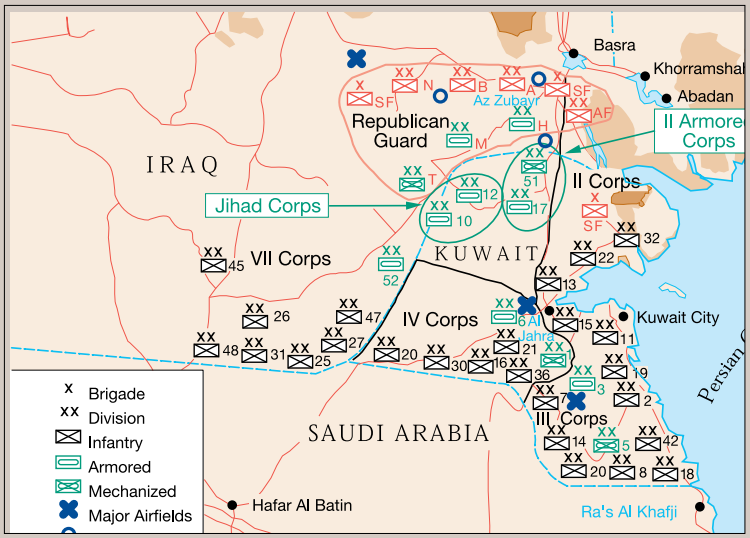
were not mobile, able to be hidden, or particularly difficult to target or damage. Also discernable were the indicators of when either electricity or petroleum were in short supply. As a result, fairly complete information is available on the measures and degree of success of attacks in attaining tactical-level or immediate results. For electrical power there was a rapid shut down of commercially generated power across the country, the major loss occurring in the initial days of the air campaign. This took place even faster than anticipated, in part because Iraqi engineers at times shut down plants in order to avoid a system overload. Some residual power, perhaps 12 percent of capacity, remained available from a number of smaller power plants in isolated regions that were not attacked. Therefore the immediate objective of shutting down the national power grid was quickly attained. The degree to which this measurable result led to the desired operational-strategic effects is, however, far from clear. Some friction was undoubtedly imposed on the Iraqis by forcing the national leadership and military systems countrywide to switch to back-up power. Quantitatively it remains difficult to ascertain how much friction was induced from the available evidence; but the national grid remained out of action.

Coalition air strikes rendered 90 percent of Iraqi petroleum refining capability inoperative, based mainly on the employment of a relatively few precision strikes against distillation towers. Air strikes destroyed a far lesser percentage of oil storage capacity because of the nature of those targets, spread over extensive areas and less vulnerable to rapid destruction. The lack of distilled petroleum caused few problems for the Iraqi military, however, through no fault of the attack plan. A fuel shortage may have affected the Iraqi air force if it had not chosen to remain on the ground. Similarly, enemy ground forces in the Kuwait theater had access to local fuel and in any case used only minimal petroleum while dug into static positions. They had more than enough diesel fuel for a 100-hour ground war, but would have soon run into difficulty finding transportation to supply fuel within the theater. Attacks on Iraqi oil supplies were effective not because of their impact on the actual combat, but in limiting Iraq's ability to conduct a protracted ground campaign.

The air attacks on the Iraqi nuclear weapons research program seemed during the war to be as straightforward as those on electricity and oil. The attacks instead provided an illustration of a seemingly good scorecard in terms of aim points hit but poor ultimate results. Reports during and immediately after the war indicated a high level of destruction against the entire nuclear program, based on analysis of damage to *known* facilities. In fact, later information showed that there was only partial destruction of known facilities, and more importantly, those facilities were only a small portion of the entire Iraqi nuclear program. Coalition intelligence information had underestimated both the size of the program and the Iraqi determination to protect it. Whereas coalition planners began the war certain of only two sites, post-war analysis by United Nations inspectors revealed sixteen main nuclear facilities and another five nuclear-related sites. Furthermore, the Iraqis went so far as to remove both nuclear fuel and machinery from buildings engaged in nuclear research from under coalition bombing and bury the items in fields, making them relatively invulnerable to precision air attacks. Even attacks on known facilities, in other words, were hitting almost empty structures at times. One could look on these poor results simply as an intelligence failure, but the more explicit lesson is the extensive intelligence data needed to successfully target capabilities like Iraq's nuclear program as a system.

The targeting and damage assessments of Scud launchers and support facilities had much in common with the experience against the nuclear program. One difference was that the Scud target set provided an additional measure of success—launch rates of the missiles. As in the case of the nuclear

Iraqi Troop Dispositions



Iraqi units deployed in the Kuwait theater during January and February 1991. Note the position of the Republican Guard and the armored and mechanized divisions to the rear of infantry divisions (all positions approximate).

Source. Barry D. Watts and Thomas A. Keaney, *Gulf War Air Power Survey: Effects and Effectiveness* (Washington: Government Printing Office, 1993).

program, however, coalition intelligence estimates did not have a full understanding of the target base and, during the war, misinterpreted the actual damage being inflicted. Iraq was known to have fixed-launch sites and a mobile launch capability for Scuds. Coalition planners thought the Iraqis would use fixed sites initially, and that the mobile launchers, though much more difficult to target, could be handled based on presumed set-up times prior to launch and other assumptions. It was not anticipated that the mobile Scud force would be dispersed to unknown locations before the start of the air campaign. Additionally, the presence of decoy mobile launchers that could not be distinguished from the real thing even at a distance of 25 yards. Moreover, in the early days of the air campaign, pilot reports and pictures of what were described to be destroyed mobile Scud launchers tended to mask the actual lack of success in destroying them. Although the Iraqi mobile Scud force was no doubt disrupted, harassed, and to a degree suppressed, coalition aircraft succeeded in destroying few, if any, mobile Scud launchers during the war.

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What, then, are the best measurements of the anti-Scud attacks, and what do the results show? The number of fixed sites destroyed appears to have little relevance in this case, and if only the number of mobile Scud launchers is considered, the attacks were a failure. The objectives point to other indicators, however, that suggest partial success, or that at least make the operations appear to have been worthwhile. One indicator is the launch rate for Scud missiles during the war, and a second is the degradation of Iraq's longer-term offensive capabilities based on the extensive attacks on production and storage facilities. As the figure on the opposite page indicates, the mobile Scud launchers if not destroyed were at least suppressed after the first ten days; the recovery towards the end of the war also indicates that the threat had not been completely dealt with. In addition, the suppression would have both cut down the number of missiles launched and diminished the accuracy of those actually launched because of a shortened set-up time and rushed procedures. In other words, one can make a strong circumstantial case for the attacks suppressing the launches and, in conjunction with the perceived effectiveness of Patriot, plausibly infer some success both in convincing Israel not to enter the war and in limiting damage caused by Scud attacks.

Attacks against Iraq's Scud missiles and its nuclear program call for subjective judgments about cause and effect in determining the success of the attacks, especially at the operational level and above. At least in these two cases, there were post-war U.N. inspections that threw further light on the levels of actual damage. In examining the evidence of attacks on the Iraqi leadership and communications, there is far less post-war information, and the available measures are just as indistinct. Complete success would have entailed removal of the leadership, particularly Saddam Hussein, in the one case, and the inability of Iraq to control its forces in the Kuwait theater from Baghdad, communicate

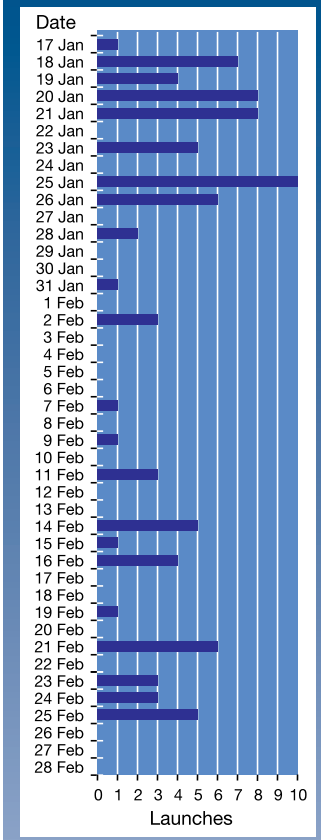
with the outside world, and maintain internal control of the population, in the other. While complete success would have been apparent, there are few objective measures for determining how far short of, or close to, that goal the coalition air campaign may have been on February 28, 1991. Measuring progress requires extensive intelligence information on both the systems and communication procedures (how the country works) and an understanding of system limits, and a capability to monitor electronic emissions.

The measures for attacks on leadership and command and communications networks begin with tactical indicators: the amount of destruction to government buildings, command bunkers, and communication sites as well as the level of monitored electronic communications and information derived from intercepts. There were also operational-level indicators, less objective but distinctive enough to show a strong correlation to the effects of attacks on these target sets. On the one hand, Saddam Hussein and his Ba'athist regime remained in power, able to communicate with the field commanders in the Kuwait theater and to continue to launch Scuds until the final days of the war. On the other hand, the Iraqi leadership was forced to relocate many times, had its communications severely disrupted, and had its control of the Iraqi people severely shaken. There were rebellions by the Kurds in the north and by Shiite Moslems in the south, and Saddam Hussein was criticized openly in Baghdad. Little more can be said. Precisely estimating the degree of dislocation that occurred would require access to Iraqi officials or records. Estimating these effects during the war itself was and probably will remain more difficult for these target sets than for any others.

U.S. Air Force (Dean Wagner)

Destroyed Iraqi Frog–7 missile along a road in the Euphrates Valley.

Iraqi Scuds launched between January 17, 1991 and February 25, 1991 (Zulu time).



Source. Barry D. Watts and Thomas A. Keaney, *Gulf War Air Power Survey: Effects and Effectiveness* (Washington: Government Printing Office, 1993).

Attacks on Surface Forces

The surface portion of the air war consisted of the attrition of enemy forces in the theater and the routes leading to it rather than the more discrete attacks in Iraq proper that had characterized the air operations against the Iraqi air force, air defense system, or the electric power grid. Bomb damage assessment focused more on measuring the cumulative effort of many sorties than scoring individual sorties. Attacks on surface forces had several components: air interdiction of supplies and transportation to and within the Kuwait theater; attacks on the Iraqi navy; and the main feature, attacks on the Iraqi army while it remained in place during the air war and in engagements during the ground phase. General Norman Schwarzkopf, USA, the Commander in Chief of U.S. Central Command, furthermore, had singled out units of the Republican Guard (named a strategic center of gravity) for special attention. That force's importance derived from its role as the strategic reserve of the Iraqi defensive strategy and from its political role as defender of Saddam Hussein's regime.

The Armed Forces gained experience prosecuting air interdiction operations in World War II, Korea, and Vietnam, but this war provided few new twists. The objectives were to cut the flow of supplies to the theater, to stop the movement of forces within the theater, and especially to stop the Iraqi forces from leaving the theater intact. Since most Iraqi ground forces were already in place when the air war began, the need to block reinforcements was limited. Geography provided the attackers some advantages: ter-

rain consisted of broad plains and farmland, providing little cover for vehicle traffic; the principal lines of communications between Baghdad and the theater generally followed and frequently crossed rivers; and the system of roads narrowed as it approached Basra. Bridges, therefore, became the key targets.

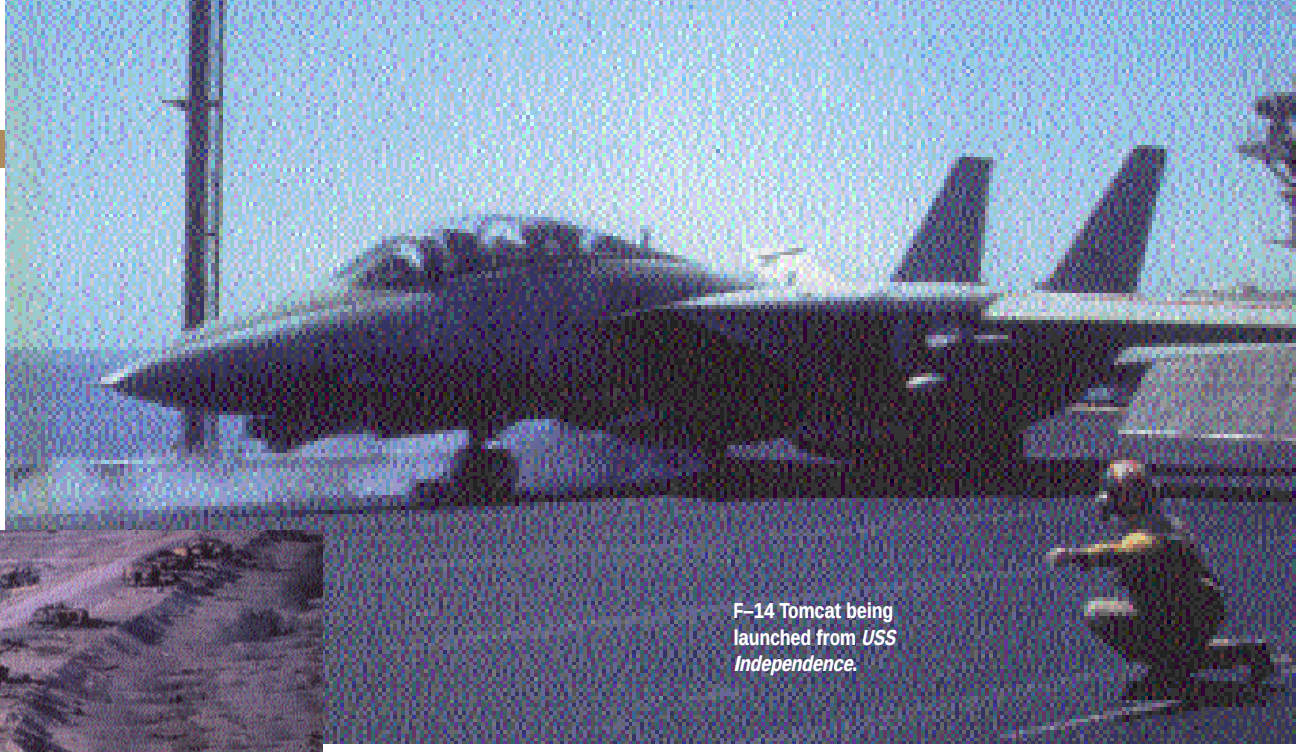
The destruction of bridges began in earnest at the start of February 1991 and proceeded quickly thereafter. Overall 75 percent of the bridges along the route to and from the Kuwait theater were damaged or destroyed. Despite the prominent role of bridges in the transportation system, however, their destruction alone was not enough. The Iraqis did not attempt to repair permanent bridges but mounted a massive effort to build earthen causeways, use ferries, and employ pontoon bridges to bypass downed bridges. Iraqi skill in coping with the loss of bridges led Lieutenant General Charles Horner, USAF, after the war to caution:

> *Anybody that does a campaign against transportation systems* [had] *better beware. It looks deceivingly easy. It is a tough nut to crack.* [The Iraqis] *were very ingenious and industrious in repairing them or bypassing them . . . I have never seen so many pontoon bridges*. [When] *the canals near Basra* [were bombed], *they just filled them in with dirt and drove across. . . .*[3]

Attacks on bridges were abetted by attack aircraft flying armed reconnaissance missions along sections of the main highways leading to and from the Kuwait theater, destroying trucks and cargo. Iraqi countermeasures included restricting travel to night and shifting from multivehicle convoys to single vehicles. Although this action saved some trucks, it slowed supplies to a trickle. The same tactics succeeded within the theater. With few bridges or choke points to target, attacks on Iraqi army trucks and others making supply runs had a devastating effect on the transportation system. Enemy prisoners of war indicated that over half of the trucks were destroyed or out of service for lack of parts, and that the drivers were no longer willing to travel the roads.

With all evidence on the success of air operations against the bridges, trucks, and entire route system, what conclusions can be drawn on the operational effectiveness of air interdiction? Coalition aircraft attacks served to greatly reduce the flow of supplies, if not sever the supply lines. In terms of the effect on Iraqi ground forces in the theater, the results were not decisive on their own because of Iraqi army inaction. As air interdiction efforts in past wars prove, operations work best when the enemy is engaged in high tempo ground operations and thus consuming supplies at a high rate. The Iraqi army was essentially inert during the air campaign, so that the limited supplies that got through, combined with large stocks positioned in the theater from August 1990 to January 1991, allowed the enemy to remain in place. Whether several more days or weeks of air interdiction operations alone would have eliminated all resupply and shattered what was left of the distribution system is a matter of speculation. What is certain is that the outbreak of large-scale ground combat increased demands for supplies (especially ammunition and petroleum) to a point where the residual flow of supplies was insufficient for prolonged conflict.

While not central to the war, air operations against the Iraqi navy consumed a significant amount of the effort, particularly for carrier-based aircraft in the Persian Gulf, and demonstrated the difficulty of operating in confined waters in the presence of even small enemy forces. Coalition aircraft attacked Iraqi naval targets to secure freedom of action in the northern Gulf, both to make the carrier and battleship firepower available and to allow the amphibious force to be in position for the deception plan and landings, if necessary. Just as in the case of targets on land, a lack of bomb damage assessment information made the threat unclear. The Navy antisurface warfare commander could not declare the threat defeated until February 17, two weeks after later analysis would show the last Iraqi missile boat was destroyed. Even with the Iraqi surface navy all but entirely sunk, however, a serious threat remained for coalition naval forces: mines and Silkworm antiship missiles. An unknown number of mines remained and missile boat destruction removed only one launch method for missiles; the threat of air- or ground-launched Silkworms continued to affect coalition navy operations until the war's end. Repeated strikes against seven suspected Silkworm sites did not remove this



U.S. Navy (Mark Therien)

F–14 Tomcat being launched from *USS Independence.*

U.S. Air Force (Dean Wagner)

Ruined hulks of Iraqi armored vehicles and trucks.

threat. Only two Silkworm launches took place during the war, both from a site south of Kuwait City on February 25, fired obviously just prior to the site being overrun. Just as with the anti-Scud operations, it is difficult to determine if further launches were in fact suppressed or if the Iraqis simply chose to retain the missiles until an amphibious attack occurred.

Air attacks against the Iraqi army in Kuwait comprised well over half of the coalition effort. The objective set for the air attacks was reduction of combat capability of that army by 50 percent. The measurement of attrition was destruction of Iraqi armor and artillery to that level throughout the theater. Air strikes began targeting ground forces on the first day of the war, then proceeded with increasing intensity throughout. All forty-three Iraqi divisions in the theater received some attention, but three Republican Guard armored or mechanized (heavy) divisions received the most, followed by the other eight heavy Iraqi divisions that made up the tactical and operational reserves. Attacks against Iraqi front line divisions (all infantry) peaked just prior to the ground offensive.

In the opening two weeks of the war results of the air attacks fell far behind the projected attrition rate, in part because of a combination of poor weather and lower than planned sortie rates, but principally because of poorer bombing accuracy and weapon performance from the high release altitudes employed. Some adjustments to tactics took place to increase attrition rates, the main one being the employment of laser-guided bombs to target Iraqi armor. Not anticipated before the war, this innovation took advantage of differences in the cooling rates of surrounding sand compared with vehicle metal, making Iraqi vehicles, particularly tanks and armored personnel carriers, stand out as hot spots on aircraft infrared sensors. Night bombing with laser designators on these spots became an extremely effective method of despatching Iraqi armor. Beginning on February 6, the bulk of the F–111Fs were shifted from strategic targets in central Iraq to nightly attacks on Iraqi armor in the Kuwait theater with 500-pound laser-guided bombs. As time went on other aircraft with infrared sensors and laser targeting pods joined in the effort. This increased the rate of Iraqi armor and artillery attrition, but the 50 percent goal for the theater was not attained by the start of the ground offensive. At that time, Central Command (CENTCOM) estimated equipment attrition rates at 39 percent for tanks, 32 for armored personnel carriers, and 47 for artillery.

The amount of equipment attrition suffered by the Iraqi army became a contentious issue at the time, and any post-war reconstruction of the facts can only partially reconcile earlier estimates. Understanding the basis of the dispute requires a review of the

THE GULF WAR AIR POWER SURVEY

In August 1991 the Secretary of the Air Force commissioned an independent study to "collect, integrate, and evaluate all observations, after action reports, and other data from Operations Desert Shield and Desert Storm." It was intended to "examine not only the planning and consequences of the air campaign in Desert Storm, but its implications for air warfare and doctrine." The effort was headed by Professor Eliot A. Cohen from the School of Advanced International Studies at the Johns Hopkins University and a group of analysts including retired officers of the Army, Navy, Marine Corps, and Air Force. The basic research covered not only Air Force records, but also data collected from the other services and from Gulf War coalition partners.

The study yielded a series of eleven reports to be published in five volumes—each consisting of two parts—plus a summary report. The reports cover planning; command, control, and communications; operations; effects and effectiveness; logistics; support; weapons, tactics, and training; space operations; a statistical compendium; and chronology. Each title is being printed in both classified and unclassified versions except for the space operations report (classified only) and the summary report (unclassified). The anticipated publication date for the series is October 1993; unclassified reports will be offered for sale to the public by the U.S. Government Printing Office.

original size of the target base, the counting rules, and the use made of the estimates. The estimates of Iraqi tanks destroyed, the most often cited case at the time of the war, provides the best illustration of the problem.

By January 1991 intelligence estimates credited Iraq with 4,280 tanks in the Kuwait theater—a number derived from estimating the standard for equipping 43 Iraqi army divisions. The 4,280 figure had also been validated by spot-checks of some Iraqi units using photo imagery. This tank count remained the baseline for estimating the percentage of tank attrition throughout the war. In other words, when 2,140 tanks were counted as destroyed, the 50 percent attrition would be achieved. Using pilot reports and imagery, CENTCOM compiled daily updates of attrition for briefings in the theater and passed this information on to the Joint Staff. Using satellite imagery as a primary source, the Central Intelligence Agency (CIA) and Defense Intelligence Agency (DIA) independently, and in collaboration with one another, prepared their estimates of tanks, armored personnel carriers, and artillery pieces destroyed, figures that soon diverged from the CENTCOM tank count, with the Washington numbers indicating far fewer tanks destroyed. By February 12, for instance, CENTCOM reported 25 percent of the tanks destroyed, while DIA and CIA reported less than half that number. By the eve of the ground offensive, CENTCOM reported 1,688 tanks already destroyed, while intelligence analysts in Washington counted fewer than 700.

The counting rules and different estimates developed were important because the percentage of degradation of the Iraqi army was key to determining when the ground offensive would begin. The CIA caused some consternation within government circles when that agency's figures became publicized in February 1991, and fears were voiced that, as in past wars, inflated damage claims were leading to miscalculation of enemy strength. Partly as a response, CENTCOM attempted to deflate the counting controversy in mid-February through a combat effectiveness model (developed by the Army element of CENTCOM) of enemy divisions that included equipment losses, but also factored in leadership, discipline, health, and so forth. In addition, rules stated that losses claimed by pilots were creditable only when imagery verified the loss. Furthermore, videos from aircraft like F–111Fs showing tank destruction by laser-guided bombs were discounted by one-half, and claims by A–10s discounted by two-thirds, to offset uncertainties. This change perhaps occurred because General Schwarzkopf was so disenchanted with specific estimates of percentages of equipment attrition that he refused to allow such data to be presented at his briefings.

Following the war and further analysis of available imagery and prisoner of war reports, some updates of the estimates were possible. First, a count of Iraqi tanks in the theater just prior to the war revealed that there were 800 fewer than earlier estimated. This error, however, was soon offset by subsequent overcounting of tank attrition, making the CENTCOM wartime estimates of attrition percentages on the eve of the ground war (February 23) approximately correct, although only due to offsetting errors. Second, imagery showed that more than 800 Iraqi tanks escaped from the theater at the war's end, making the number of tanks destroyed—since few, if any, additional Iraqi tanks entered the theater in that period—through both air and ground action approximately 1,000 less than CENTCOM claimed at the end of the war. Finally, tank attrition on the eve of the ground offensive was about 40 percent for the Iraqi army overall and just over 20 percent for Republican Guard units; and the total wartime Iraqi tank attrition was approximately 75 percent and 50 percent, respectively. In other words, the most important Iraqi units got off with the least damage. Although far from the least attacked, Republican Guard tanks were better dug in and defended. Another contributing factor was that these tanks were far enough to the rear to escape the theater; tanks farther forward, even if functioning, had to be abandoned.

DOD

B–52s made up only 3 percent of all coalition combat aircraft but delivered approximately 30 percent of total bomb tonnage, mostly non-precision munitions.

Measures and the use made of them had a number of flaws. The most obvious problem is with the size of the target base. While the number of tanks in the theater continued to be reported as 4,280, there were widespread reports during the war that the numbers were wrong. Intelligence reports from autumn 1990 and prisoner of war debriefings during the war indicated that many units had deployed with far less than a full complement of men or equipment (intelligence reports in a similar way had also overestimated the number of Iraqi soldiers in the theater, but accounts of Iraqi personnel attrition, body counts, were scrupulously avoided).

Even if the number of tanks was correct, too much attention attached to it as a measure. When the attrition goals were set in September 1990, the tanks represented what would have been the vanguard of an Iraqi attack into Saudi Arabia. By January 1991, no ground commander set a particular premium on destroying tanks from the air. By then, it was artillery since Iraqi artillery represented the chief danger for blunting the ground attack through use of chemical weapon shells during the breaching effort. The Army corps commanders, Lieutenant Generals Gary Luck and Frederick Franks, and Lieutenant General Walter Boomer, USMC, commander of Marine forces, pointed to artillery as the chief obstacle. Boomer even went to the extreme of talking with his airborne Marine pilots to direct their energies toward attacking artillery instead of armor. Iraqi tanks were not in the front lines in any numbers, and the corps commanders were confident in being able to handle them in a war of movement, both by air—since tanks on the move were more vulnerable—and by using the superior range of the M–1A1 tank.

the most important Iraqi units got off with the least damage

Ironically, the loss of equipment, the key index of damage assessment during the war, was not decisive in any direct way. The key to the defeat of the Iraqi army was not the specific targets destroyed, but the combination of targets attacked and the intensity with which attacks took place. Enemy soldiers were affected by the bombs that hit their targets as well as by those that missed. The air interdiction effort, damage to communications and supply systems, along with equipment attrition during the air war, affected the Iraqi soldiers beyond the direct inflicting of casualties. The Iraqis did not defect or surrender in droves during the air and ground war because their armor and artillery were being destroyed—in fact, statements by prisoners of war indicated they appreciated the discrimination of coalition air forces in aiming at equipment instead of at them—but because of shortages of food, water, and confidence that their equipment was going to do them any good. The Iraqi army did not run out of tanks, armored personnel carriers, or artillery; in fact, much of the equipment intact at the start of the ground offensive was abandoned, or at least unoccupied, when coalition ground forces arrived. The total number and operability of tanks had less meaning under these conditions.

Reviewing the disintegration and rout of the Iraqi army during Operation Desert Storm, one becomes suspicious of the value of relying on discrete indicators to measure results. Even in such a brief, recent, and militarily lopsided campaign, broader problems of assessing (*not* measuring) operational and strategic—as opposed to tactical—effectiveness remain difficult, controversial, and plagued by subjectivity. While tactical effects and effectiveness are seemingly more amenable to quantitative measures, the need to take into account the actual, real-world objectives of operational commanders and planners suggest that operational-strategic effectiveness is, in the end, essentially a qualitative issue. The fact that coalition air forces did not destroy the promised 50 percent of Iraqi armor and artillery in the Kuwait theater prior to the beginning of the ground offensive does not lead to a conclusion that coalition airpower failed to create the circumstances under which the 100-hour blow-out on the ground was possible.

U.S. Army (J. Otero)

Iraqi MIG–25 after being destroyed during Operation Desert Storm.

The lessons derived from assessing bomb damage in the Gulf War involve both improving methods and facing the inherent messiness and uncertainty of real war. Methods for determining the tactical effects of bomb damage can be improved. This will require both better skills on the part of interpreters of bomb damage and better equipment. In the age of dumb bombs pilot reports of estimated damage were often only one small piece of a picture of how attacks were progressing that built up over weeks or longer. In our age of hundred-thousand, even million-dollar munitions in which numerous revisits to the target are no longer desirable or affordable, there is no alternative to a high-quality damage assessment capability on the attacking aircraft or the weapon itself. The F–16 and F/A–18 aircraft, among others used in the Gulf, had no such capability.

ironically, the loss of equipment, the key index of damage assessment during the war, was not decisive in any direct way

Improved capabilities to hit within 8-12 feet of aim points with precision-guided weapons represented unprecedented advances in theater-level bombing accuracy. The problems of grasping the vulnerability and functioning of entire target systems vis-à-vis operational-strategic objectives, however, may well have been as riddled with uncertainty in the cases of the Iraqi nuclear program and mobile Scud missile capability as were target systems like ball-bearings during World War II. Hitting aim points is getting easier, but knowing what aim points to go after across an entire target set remains, in general, open to uncertainty when facing a dedicated, reactive adversary.

Finally, there are the difficulties of assessing effectiveness across diverse but interrelated target systems as well as the impossibility of finding measures that can be readily applied across all target sets. There was nothing in the Gulf War data that supported the existence of universal or quantifiable measures of operational, much less strategic, effectiveness. In other words, you can never have information available during the war to know exactly how you are doing. In this sense Clausewitz had it right when he observed:

Many intelligence reports in war are contradictory; even more are false, and most are uncertain. What one can reasonably ask of an officer is that he should possess a standard of judgment. . . . He should be guided by the laws of probability. These are difficult enough to apply when plans are drafted in an office, far from the sphere of action; the task becomes infinitely harder in the thick of fighting itself, with reports streaming in. At such times one is lucky if their contradictions cancel each other out. . . .[4]

The principal audiences for these lessons are not analysts and historians of past campaigns, but planners and commanders who must assess the effects of air bombardment, make adjustments, and draw conclusions long before complete information becomes available. For them the lessons of this survey may seem particularly bleak, but there is a certain cold comfort in truly understanding the nature of the task at hand rather than trying to find certainties where none exist. JFQ

NOTES

[1] See two forthcoming reports, Barry D. Watts and Thomas A. Keaney, *Gulf War Air Power Survey: Effects and Effectiveness* (Washington: Government Printing Office, 1993); and Thomas A. Keaney and Eliot A. Cohen, *Gulf War Air Power Survey: Summary Report* (Washington: Government Printing Office, 1993).

[2] U.S. Department of Defense, *Conduct of the Persian Gulf Conflict: Final Report to the Congress* (Washington: Government Printing Office, April 1992), pp. 95–98.

[3] Interview with Lieutenant General Charles A. Horner, USAF, conducted at Shaw Air Force Base, South Carolina (March 4, 1992), by Perry Jamison, Richard Davis, and Barry Barlow of the Center for Air Force History.

[4] Carl Von Clausewitz, *On War*, edited and translated by Michael Howard and Peter Paret (Princeton: Princeton University Press, 1976), p. 117.